

Simulating bodily movement as an agent for the reactivation of forgotten open air spaces in the city

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Abstract – *This paper presents experimental work that uses immersive technologies for engaging users and local communities in the design process of architectural interventions on historic, fragmented environments in an effort to re-activate the place under study. In addition to the use of cutting-edge methods of capturing and analysing on-site information, this research framework, implemented in the on-going study of Paphos Gate area of historic Nicosia which lies on the infamous Green Line that still divides the city, explores the potential of narrative-led visualization to enable personal interpretations of space and its history. This virtual environment hosts reconstructions of the Paphos Gate neighbourhood which were produced based on archival material and via 3D data acquisition (LiDAR, UAV and terrain Structure-from-Motion techniques), in order to explore the associations between the transformation of the monument through the years – from its construction to present day – and the bodily experience of the visitors sojourning in its surrounding part of the city. The vision of this research is to develop a digital platform which through immersion, cinematic language and storytelling will enable the evaluation of alternative scenarios and design interventions in the context of the management plan of forgotten open air spaces that used to be popular within their urban fabric.*

Keywords— Social sustainability in smart cities; imersive technologies; interactive narrative-orientated participatory design; built heritage; re-activation of forgotten urban spaces

I. INTRODUCTION

This paper presents an on-going research that integrates digital tools of documentation - used in conservation and preservation studies - with state-of-the-art immersive technologies to contribute new practices of urban space reactivation and enable interdisciplinary contributions to site management. In this context, an interdisciplinary team of experts on archaeology, architectural history, urban studies, virtual environments, spatially distributed storytelling and computational simulations from the Cyprus Institute, is collaborating with the National Center for Supercomputing Applications at the University of Illinois at Urbana-Champaign, with the support of Cyprus Department of Antiquities and the Municipality of Nicosia to develop a virtual platform that enables urban space simulations. This research uses as a pilot project the study of an important area of the historic city of Nicosia, one of the remaining divided capitals. The Paphos Gate, baring a complex history, as an integral part of the iconic Nicosia fortifications –one of the very few examples of heritage acknowledged by both Greek-Cypriot and Turkish-Cypriot communities - located directly on the buffer zone, used to be in decay for many decades, laying forgotten and detached from both the historical and contemporary city fabric.

This research pursues two objectives, one is to support scholarly inquiries regarding the history and cultural value of the place [1], including educational opportunities for tourists and locals alike, and the other aims at the experimental use of immersive technologies for the re-activation of the area of the Paphos gate – and its re-association with the fabric of Nicosia. This paper is occupied with the presentation of the latter - more information regarding the use of ICT in heritage sites as a means to contribute to the transformation of historic areas of the city into open air museums can be found elsewhere [2]. This research considers the physical space of the Paphos Gate as a staged urban environment, which can be explored in context only through interacting with spatialized narratives offered to its users through immersive experiences. The latter are staged within a virtual environment. Through the planned operation of interaction booths, installed on site and at the premises of the participating in this effort research organisations, this virtual environment will serve as a testing platform for the municipality, the stakeholders, researchers and professionals working in the field to simulate possible urban planning strategies prior to their implementation.

This paper will present the contributions of this research to the creation of a life project (Living Lab) involving the development and post-excavation management of a forgotten historic site. This is achieved by means of a participatory process of designing architectural interventions that aims to reintroduce the site into the everyday life of the contemporary city of Nicosia, and by doing so this approach to urban space rehabilitation contributes to practices of collective identity, social cohesion and inclusion ([3], [4]). The overarching goal of this research is to complement the concept of smart cities with alternative digital methodologies of social sustainability by approaching cultural heritage as a dynamic assemblage of events, activities, performances and identities that relates to space as well as people.

II. URBAN SPACE AS THE MATRIX OF CULTURAL IDENTITIES

The concept of this research revolves around the dynamic relations between historical urban environments and users, identities, communities and their associated memories [5]. The complexity of contemporary cities - even more so in historically layered cities - has grown to unprecedented degree in their history ([6], [7], [8]) while it is acknowledged that there are different ways of studying and approaching their challenges ([9], [10], [11]). Europe has emerged through the successive competition of colonial powers and historical narratives that weaved the complex mosaic of cultures, languages and religions that comprises the region. The pilot project of this research involves one of the gates of the old city of Nicosia, an urban site that lived through severe transformations since medieval times and in particular during the end of the 19th century.

The middle of the 19th century is considered to be a significant starting point in humanities for the establishment of national narratives - emerging in the 18th century, these processes started creating national identities and ethnocentric cultures - and crystallization of borders

among European countries, a historical process that led to two World Wars in the 20th century, which manifested long-standing tensions in the continent. On the other hand, this period was characterized for the creation of common efforts for increasing interconnections between countries and markets and the urbanisation phenomenon of European cities, as result to the Industrial Revolution which created most of large centres across the continent; actually only a few European cities date from the 20th century. These phenomena of modernisation contributed largely to the acceleration of cultural exchanges between nations, while they provoked transformations and blurring of identities in friction, and transferred the existing historical tensions from remote national borders into the city. The process of the territorialisation of this friction generated enclaves of competition within the urban space, the study of the repercussions and effects of which occupy the presented research.

III. THE ROLE OF CULTURAL HERITAGE IN THE SUSTAINABLE DEVELOPMENT OF THE CITY

Today's fracturing of national and cultural identities and boundaries, exacerbated by global economic and political crises, intensifying migrations of people and consequent hostile tensions across borders internationally and within Europe, means that historic cities are facing acute cohesion challenges of physical, sociopolitical and/or cultural division. The integration of existing and opposing cultures, migrants and settlers, is arguably the most pressing challenge Europe is facing in our era. In this context how can we map the relationship between identity, collective memory and spatial experience in the urban environment, with a view to aiding the development of cohesive, inclusive and successful cities? And what is the relation of heritage with the space of the city?

The built environment is punctuated with spatially-expressed resources identified with the territory they occupy, like monuments, squares, parks, streets, markets, museums, landmarks, etc. This research acknowledges that the spatial aspects of heritage include not only historic places associated with culturally-significant people and events, like archaeological sites or finds of important ethnic, national or universal value, but also landscapes, built environments and public spaces, like streets and squares. In a city, culturally-significant sites co-exist with contemporary interventions, and the holistic management of heritage sites' everyday life involves not only their preservation and study, but also their symbiosis with new structures. Thus the study of heritage cannot be separated from its environment.

The affordances of this symbiosis contribute to the sustainable management of the city as a whole due to their impact on the social sustainability of the communities that inhabit the city. All these territories host the performing of everyday, mundane – but occasionally singular and unique – events. The emergent complexity of this terrain, comprised of the assemblage of these territories, stimulates citizens and users of the city during their everyday activities. These stimuli incite a wealth of emotions to the users, while the concurrent

responses to these emotions, their expression or the lack thereof, generate patterns of occupation and spatialised tensions. Occupation and use of resources produces tension due to multiple competing stimuli. The production of these tensions, frictions and pressures that are expressed, and exercised, in the space of the city happens through a continuous process of re-identification.

This is what digital technologies of interaction, data management and communication should focus on if they want to contribute to the social sustainability of the smart city. This research builds upon the widely recognised approach to preserving and promoting the role of cultural heritage as a driver for the sustainable development of the city. Heritage can be used to influence positively the social cohesion of neighbourhoods as it could be promoted in such a way that, instead of provoking tensions and division, it would offer spaces of inclusion, interesting everyday experiences and provide a sense of belonging to socially excluded communities [12]. These capacities of cultural heritage along with opportunities for learning and social interaction, offered to their users by heritage places when these succeed in becoming part of the everyday life of a city - i.e., part of the network of its communal amenities and common resources - contribute also to the well-being and quality of life of the citizens. In this context this research pursues the following inquiries:

- in terms of technique: how to couple reductive models, and computational simulations, with uncertain user behaviour in order to observe unpredictable points of view, or in other words, how to simulate the dynamics of the social aspect of shared historical space?
- in terms of content: how to articulate new interpretations of past practices? and,
- in terms of context (purpose): how to study the role of heritage in the future development of the city and how to further enhance the impact of the former to the latter?

The rest of the paper is occupied with an analysis of the above three thrusts of research inquiry.

IV. SIMULATING THE FUTURE: DIGITAL TECHNOLOGIES OF SIMULATING AGENCY

The presented research explores how technologies like immersive projections and interaction interfaces, movement tracking and body analytics sensors, geo-location, mapping and visualisation tools, 3D documentation, digital reconstruction and computational simulation techniques can be combined in order to enable interdisciplinary studies of the above continuous process of re-identification. These technologies, sourced from architecture, engineering, the gaming industry, ICT and cinema, are important for this study as they enable scholars, researchers - and in general the stakeholders of the city - to observe, explore and ultimately understand the interactions of the stimuli that are actualised in the public space.

This instrumentalised method will hopefully facilitate a more dynamic approach to the study of patterns of occupation, and their respective spatialised tensions, than typical methodologies of ethno-geographic studies and urban analysis [13]. This capacity of the presented tooling is significant as these events are formalised in time. Hence the need for tools and methods capable of dealing with the dynamic conditions of data produced in

time. The presented research pursues this need by means of representation tools that offer real-time immersion opportunities to their user, for the study of staged places, such as monuments of cultural heritage, requires a dynamic understanding of how different events of socialization, identification and urban friction, are influencing each other in time.

Another important aspect of urban space is the social dynamics actualised within it. This transforms it from static space into a dynamic place that in order to be studied requires alternative methods and tools, different to the reductive representations of users via simplified rule-based models and micro-economic based modelling of human behaviour. The tension of urban space is the result of the presence of stimuli and this, in turn, transforms citizens into active users, agents. Within this space, agents act in (sometimes) predictable ways (which can be simulated via stochastic and probabilistic models, e.g., fuzzy logic) but occasionally they respond to stimuli with uncertainty. While these agents respond to non-predetermined, and sometimes inexact stimuli, they also exercise influence in order to pursue their own personal goals. Thus public space, and even more so heritage space, becomes a stage that hosts these conditional performances of subjects with singular behaviours - agents who behave like actors that improvise. How can this capacity for improvisation be offered to the user in simulated environments?

V. STAGING THE PAST: USING COMPUTATIONAL VISUALIZATION AND IMMERSIVE STORYTELLING TECHNIQUES FOR THE STUDY OF SPATIAL IDENTITIES IN THE CITY

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Representing tangible and intangible heritage raises questions regarding the recovery of original meaning vs. the critical production of knowledge. Every study of heritage in the built environment is an intervention in the present and thus it is the product of a creative process of the subjective vantage point of the authority (e.g., archaeologist, historian). Distinct from this singular, top-down approach to the representation of history, this research relies on the capacities of digital visualization technologies in engaging users with 'weak' narratives [14]. In his book Rancière [15] suggested that educators should consider equality (in terms of knowing and not knowing) as a starting point rather than a destination. The methodology of the educational component of this research resonates Rancière's concept of the 'ignorant educator', insofar as it is not interested in guiding visitors towards prescribed ends but rather in activating them to explore associated events towards multiple directions, starting from the same 'entry-point'. This framework enables the creation of educational spaces where the user is in the event related to the space, an event that can be new and not a re-enactment of the past and is further analysed elsewhere - as it is beyond the scope of this paper ([16], [17]).

VI. ENABLING THE PRESENT: THE LIFE PROJECT OF THE PAPHOS GATE

The experience of historic urban environments remains an ideal context to probe questions of socioeconomic development and cultural identity. The Eastern Mediterranean preserves

significant examples of cities whose continuous history can be traced all the way back to Prehistory and Antiquity. In particular, the capital of Cyprus, Nicosia, is considered amongst the most contested urban environments having historically layered pasts and perplexing present-day realities in Europe [18]. Between 2013 and 2014 the part of the moat outside the Paphos gate was excavated in an effort led by the Cyprus Department of Antiquities and the Municipality of Nicosia not only to preserve the history of the area and the medieval fortifications, but also to develop and reactivate the neighbourhood. This was an area forgotten and disused during the last couple of decades due to the gradual movement of the commercial and cultural activities away from the old city centre to other parts of Nicosia. The rehabilitation of the historic site of the Paphos gate is co-funded by the EU while the aim of the excavation activity was to unearth and promote the historical continuity of the place from the Middle Ages until today - the gate operated without interruption during the Venetian, Ottoman period and the British rule.

The importance of the site stems from its location, its operation and historical use, its proximity to significant landmarks of the city, as well as its continuous transformation in terms of architectural configuration and built construction through the centuries. Specifically Paphos gate is constructed from parts and building material in secondary use, sourced from other nearby constructions and earlier buildings in the area during medieval times. The site is considered by this research as the locus of a 'thick' slice of the palimpsest of the historic city. First is the devastating presence of the buffer zone running through the site at its thinnest section, like a thread stretched against the medieval walls at the north side of the area, and the Holy Cross Catholic Church of Nicosia, which lies on the buffer zone with each side of the building being accessible from the respective part of the city. Then there is a United Nations station overlooking the site, and also the Kastelliotisa hall, which was used in the past as a female convent and was originally part of the Lusignan palace (13th-14th c.); the Police headquarters built on top of the gate - an addition that changed completely the structure and form of the Paphos gate (Fig. 1[6]); and the carcass of the Spitfire coffee shop (Fig. 1[7]), which was popular among the British soldiers, standing next to the gate reminiscent of the final years of British rule on the island. These are only but a few important elements of the urban environment and historical context of the archaeological site. All these historical moments create a layered aggregate of stimuli, emotions, frictions, pressures and tensions that compile a complex mosaic of heritage identified with so many different conditions, events, communities and stories in the past that can only be approached as shared - as it cannot be identified with any single origin.

In addition to that, the site was chosen as a pilot demonstrator by this research because of its foreseen future role in the network of public spaces of the city. There is ongoing political discussion between the two communities of the island to open the border and create another crossing between the two sides of the divided city - which will operate together with those at Ledra Palace and Ledras street. This forthcoming change will transform the area yet again, which is thus expected to become popular tourist destination. Therefore there is a pressing need for it to be reintegrated in the circulation network of the city. In

this context the development of a post-excavation management plan for the archaeological site, which will be complemented by architectural interventions that will enable it to serve the city, became a priority for the Municipality and the Department of Antiquities. The research team proposed to the stakeholders of the city that this hybrid space should operate between the open-air historic site [19] and the network of public spaces and should not become a controlled archaeological site.

To pursue this strategy, a virtual environment is currently in development that presents a large part of the Greek-Cypriot Nicosia¹ and focuses – by means of a pilot study – on the reconstruction of the Paphos Gate neighbourhood. This reconstruction is produced with the use of archival material and on site documentations via 3D data acquisition (e.g., LiDAR, UAV and terrain Structure-from-Motion techniques). According to the concept of engaging users in ‘weak’ narrative structures and the use of storytelling, as discussed above, this virtual environment offers exploration opportunities of the associations between the transformation of the monument through the years – from its construction to present day – and the bodily experience of the visitors sojourning in its surrounding area of the city (Fig. 2). As mentioned in the introduction, this paper is occupied with a presentation of the thrust of this research project that regards the opportunities of participation offered to users in the design of the architectural interventions on site. This methodology of engaging the users relies on virtually delivered occasions of interacting with educational events, which are spatially distributed on site, that aim at the re-association of this historical place with the everyday life of the public space.

In this context the presented research thrust aims to create a virtual laboratory of urban exploration that allows the participation of citizens-users in the design and management of the historic site. To do so, the concept of this virtual laboratory is based on the application of design thinking in the process of the post-excavation management of the site. This is pursued by offering to stakeholders of the city opportunities for engaging with the production of the intended interventions through their participation in the designing of the spatial configuration of walking routes in simulated open-air green spaces (Fig. 5; 3).

VII. INTERACTION DESIGN METHODS AND STRATEGIES OF VIRTUAL PARTICIPATION

The application of the concept of gamification [20]; [21] in community design and urban planning, through the use of interactive visualizations of public space, in order to enable participation of local communities – and help individuals that are typically excluded to raise their voice – is an area of design research that is currently attracting significant attention from architects, civic authorities and policy makers [22].

¹ Urban SILENCE (UK), the Cyprus Institute and Wagstaffs Design (UK) were commissioned by the Municipality of Nicosia to develop a 3D interactive platform for the promotion and presentation of newly developed areas of the city along with planned urban regeneration projects (2015).

During the last few years series of initiatives that promote community engagement and facilitate social interaction, like the UN Habitat activities and workshops that are occupied with placemaking, have started experimenting with new dynamic methods of participation that resort to screen-based 2D gameplay. Arguably this approach enables facilitators to collect information from secluded communities, whose interface with governmental support groups and institutions, and therefore their well-being, is challenged by barriers of language and lack of communication, as they are most of the time excluded from public consultation and the relevant discussion.



Fig. 1.[1] Paphos gate, in B&W; [2] Nicosia's Holy Cross Catholic Church, which lies, similarly to the gate, atop the thinnest part of the buffer zone that divides the city; [3] The 'Green Line;'
[4] The moat around the walls; [5] the Kastelliotisa hall.

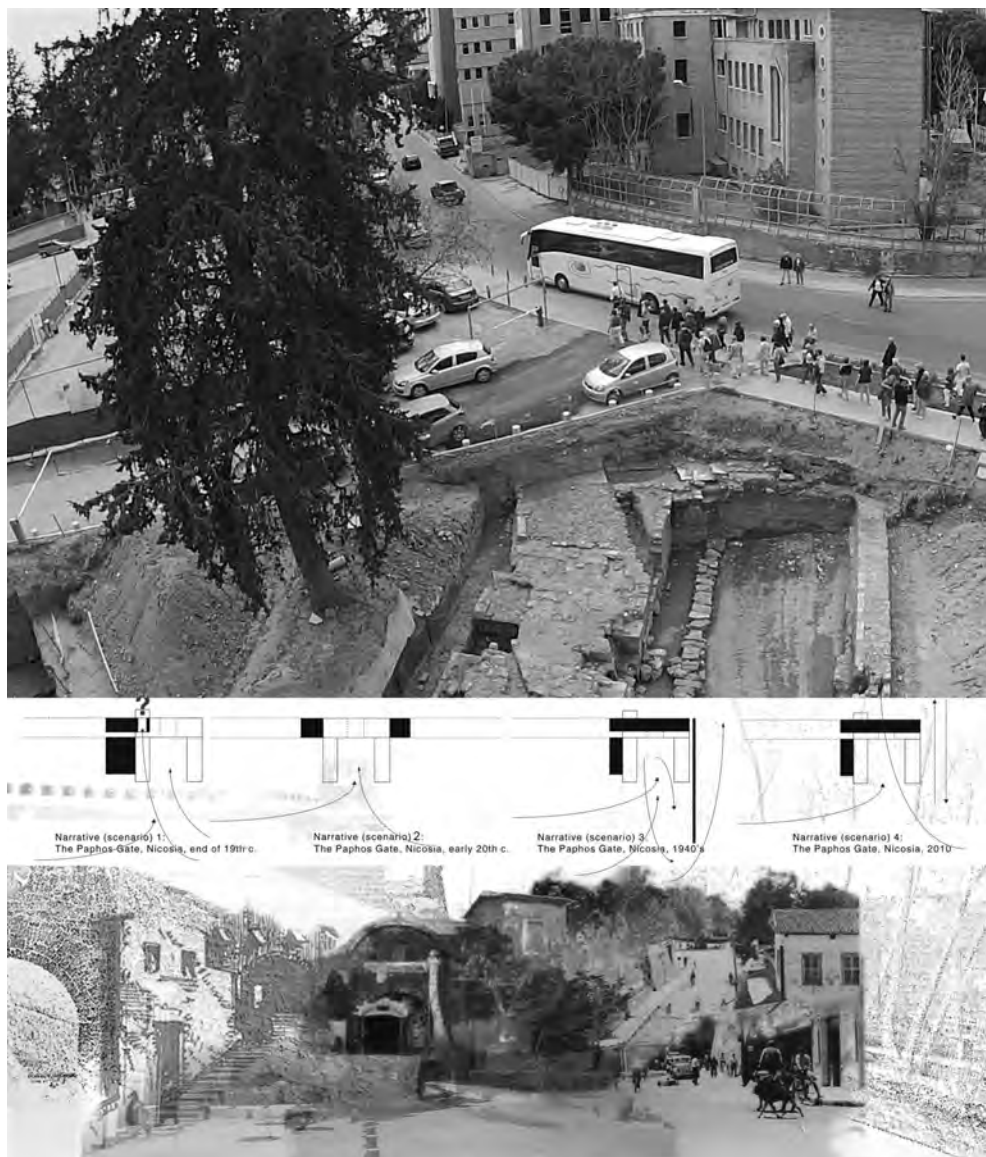


Fig. 2. [top] Photograph from drone footage that shows how the site is degraded and cut off the pedestrian network in the area; [middle] Four historical phases of the Paphos gate, and diagrams of the circulation in and around it; [bottom] The contemporary reality of the studied public space, a popular tourist destination, as formed by the co-existence of parallel 'dimensions' of alternative realities, e.g., a construction complete as it used to be, or as it is planned to become, allows researchers and professionals to experiment, test and explore hidden conditions of the built environment and also invite visitors - citizens and tourists - to learn from past stories, imagine their place in the new conditions presented for the city and immerse themselves in staged places.

Specifically, Pontus Westerberg, Digital Project Manager for UN Habitat highlights the role that the popular online video game *Minecraft* had in enabling a group of fishermen in Haiti, who couldn't read, couldn't write and had never used a computer, to design a plan for Place de la Paix, as it [...] "really let them visualize the changes they wanted to see in that space" [23]. Trying to contribute further to this effort, this paper suggests that when interactivity, and gameplay, is combined with historic narratives, bodily presence and design opportunities, it can offer rich, and articulated, insights to communal viewpoints and local identities that are otherwise difficult to capture verbally.

The presented research contributes to this exploration by extending the above methods of user engagement, which is now pursued through a triptych of techniques, as presented in previous sections of this paper: a) immersive techniques of virtual environments; b) human-computer interfaces for bodily interaction; and, c) spatially-distributed narratives. A wide range of visual interfaces and digital assets, like real-time walkable 3D models, pre-scripted explanatory animations of artefacts' use and operation, weather and vegetation computational simulations – produced with input from bio-archaeologists, dynamic sound-scapes, textual and visual archival material (e.g., maps, drawings and photographs), and more, enrich the visit of the virtual space in order to offer research opportunities and an immersive experience to the user. Exploration of the virtual narratives is facilitated by the storytelling-orientated structure of the interaction system.



Fig. 3. Visualisation of a design scenario proposed for the walking paths that the Department of Antiquities and the Municipality of Nicosia are planning to implement on site.

When the virtual environment is loading for the first time, it presents a list of roles to the user - visualised via the use of avatars - that relate to the historical period s/he wants to visit and it asks for a selection. After the user has identified a role, s/he can start exploring the projected environment at the respective period. This virtual space hosts spatially distributed 'bubbles'/hotspots, which, when s/he moves within any of them, his/her

movement triggers the screening of an explanatory, pre-rendered, cutaway sequence (animation). Introducing ‘exploration for learning’ incentives and narrative inquiries in virtual space adds a new level of engagement with the tools of spatial analysis and will hopefully contribute to the long standing discussion about new technologies of representation and their role in understanding and constructing built environments [24].

Digital methods of urban analysis have been criticized for not integrating notions of bodily movement into space, since computational environments are often considered to be scale-less and body-less [25], and the present research contributes to overcoming this limitation. It does so by means of the human-computer interface it employs, as the interaction with the visual interfaces and digital assets of the platform occurs through a virtual reality gear that enables body motion tracking, as presented elsewhere [26] (Fig. 4). Most notably the film industry, art scene, gaming industry, storytelling, journalism and healthcare, are currently investing heavily on virtual reality (VR) technologies as they provide a ‘good enough’ interaction system for the user-interface (UI) that is more ubiquitous and less obtrusive than typical computer interfaces. Following a long line of evolution from I.E. Sutherland’s experiments in the 60s², VR is again at the forefront of interaction design because of its capacity to provoke emotions of empathy, project virtually any imaginable location and situation and, most importantly, because it can offer to a certain degree the sense of ‘presence’ to its user.



Fig. 4. Setting up and testing the 1st generation of interaction hardware at the Visualization Lab (at the Cyprus Institute).

This ‘exploration for learning’ incentive then serves as the vehicle for the research to empower visitors and citizens of the city, as well individuals and communities that may

² Cf. Sutherland’s The Ultimate Display, a head-mounted three-dimensional display (Sutherland, I.E., 1965. The Ultimate Display. Proceedings of IFIP Congress, 2, pp.506–8).

be excluded, by enabling them to raise their voice and participate in the future development of the public space via a dynamic method of registering and documenting personal choices and tolerances. This becomes possible through the 'virtual world creator' feature of the platform. The virtual platform allows users to choose, sketch, follow and virtually explore paths and routes inside the projected space in order to offer their personal account of how the specific public space should operate and consolidate their understanding of the complex urban space. The real-time exploration of a projected space extends the participants' experience of street walking into a journey of exploration, discovery and understanding spatial relations.



Fig. 5. The interface involves a mobile app for the sketching of proposed routes in and around the historic site by users. These routes are then created in the virtual environment in order for their 'designers' and others to assess them and express their opinions (©Colter Wehmeier).

VIII. CONCLUSIONS AND BEGINNINGS

Recognizing the body of work produced by CASA Centre (the Bartlett, UCL) and the application of Space Syntax for the study of the complexities of urban space, the vision of this research is to develop a digital platform which through immersion, cinematic language and creative opportunities offered through participation in the design of public infrastructure in the city will contribute to the reactivation of forgotten open air spaces that used to be popular landmarks within the urban fabric of European cities. In the case of the presented pilot project, the Municipality of Nicosia and the Cyprus Department of Antiquities are supporting this effort (Fig. 6), and they are currently planning the construction of the proposed walking paths, along with the installation of VR-enabled interaction devices, in the archaeological site of the Paphos gate.



Fig. 6. An early result of the collaboration with the Department of Antiquities and the Municipality of Nicosia is the installation of light projectors that project some of the inscriptions found on site onto the walls of the tunnel of the gate in order to enable passers-by to see them.

The methodology presented enables the observation and assessment of the successful integration of the heritage site in the urban fabric through a number of recorded indicators, like the degree of information transmission and the successful communication of content, the accessibility of the site and its clear linkages with the rest of the circulation network of the city – e.g., both visual and physical connections, the image of the place, the relevance of the activities planned to take place on site, as well as, whether users recall personal accounts of events that happened on the site, and document associated memories. Data collection involves not only questionnaires but mostly tracking movement information, voice recordings and assessment of the proposed routes and paths across the site [27]. Positively assessed spaces would justify a sense of connection with the place and would therefore highlight the significance of that simulated space for the social sustainability of the neighbourhood. Community participation in planning is important for sustainable cities and this research is an example of how heritage can complement current ‘smart’ retrofit policies and contribute to the holistic development of historic cities.

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